

# OPTICAL POWER CALIBRATION AT THE OUTER EDGE OF AN OPTICAL STORAGE CARRIER

## BACKGROUND OF THE INVENTION

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### 1. Field of the Invention

The present invention relates to a method of optical power calibration performed by the optical storage carrier player, such as the CD-R/RW drive, and more particularly, to a method of optical power calibration where calibration is performed at the outer edge of an optical storage carrier, such as a compact disc (CD).

### 2. Description of the Prior Art

15 CD-R and CD-RW drives (optical storage carrier player) now are popular PC peripherals. In general, the CD-R/CD-RW drive performs an optical power calibration before actually writing data onto a compact disc (CD, optical storage carrier), such as: CD-R/CD-RW disc. 20 The purpose of the optical power calibration is to determine an optimized writing optical power. Typical optical power calibration involves writing information to a power calibration area (PCA), which is located closed to the central portion of a CD disc. This information written on the power calibration area through the power calibration is read back, and the CD-R/CD-RW drive determines an optimized optical power from the signal reflected from the CD disc, and then the CD-R/CD-RW drive writes further data onto the CD 30 disc by applying the optimized optical power.

Please refer to Fig. 1. Fig. 1 is a side view of a CD 10. The CD is a thin circular disk that is symmetrical about a centerline 11. The CD's specification is given in the Orange Book. The CD 10 comprises a central portion 12, a Power Calibration area (PCA) 14, located outside the central portion 12, a data storage area 16, located outside the PCA 14, and a last possible lead-out area

18, located near the CD outer edge.

Please refer to Fig. 2. Fig. 2 is a perspective view of the PCA 14 shown in Fig 1. The PCA 14 comprises a test area 20 which allows a test data written thereon during the power calibration, and a count area 22 in which a count of the number of power calibrations already performed in the PCA 14 is recorded. According to the specification in the Orange Book, the test area 20 and the count area 22 are divided into 100 partitions 20a, 22a, respectively. Therefore, the optical power calibration can be performed up to 100 times.

However, after the CD disc is unloaded from the tray or the tray is moving out once, at least one optical power calibration is necessary to be performed for starting a new data writing action. According to the CD-disc standard described in the Orange Cook, the 100 partitions available on the PCA limit the number of times available for writing to CD-R disc.

#### SUMMARY OF THE INVENTION

It is therefore one aspect of the present invention to provide a method of optical power calibration in which calibration is performed at the outer edge of a CD, increasing the number of times optical power calibration can be performed.

According to one aspect of the invention, a method of optical power calibration comprises the following steps:

- step 1: provide data to be written;
- step 2: control the access device to perform an optical power calibration in the outer power calibration area;
- step 3: according to an optical power calibration result, determine the writing optical power; and
- step 4: control the access device to write the information on the CD.

Another aspect of the invention further provides a CD-R/RW drive. The drive has an access device for writing data on a CD. The CD comprises a central portion, an inner power calibration area, located outside the central portion, a data storage area, located outside the inner power calibration area, and an outer power calibration area, located outside the data storage area.

A still further aspect of the invention further provides a control apparatus that controls a CD-R/RW drive. The control apparatus controls the access device to perform optical power calibration in the outer power calibration area to determine a optimized optical power, then writing information on the CD, according to the optimized optical power.

Another aspect of the invention provides a CD. The CD has a central portion, an inner power calibration area, located outside the central portion, a data storage area, located outside the inner power calibration area, and an outer power calibration area, located outside the data storage area. The outer power calibration area is used to perform an optical power calibration to determine an optimized optical power.

It is one advantage of various embodiments of the present invention that the calibration method with calibration in the outer edge of a CD can be performed in both the PCA and the last possible lead-out area, so that optical power calibration can be performed over 100 times.

These and other aspects of the present invention will no doubt become apparent to those of ordinary skill

in the art after reading the following detailed description of the preferred embodiment which is illustrated in the various figures and drawings.

5 BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a side view of a CD according to the prior art.

10 Fig.2 is a perspective view of a Power Calibration area as shown in Fig.1.

Fig.3 is a perspective view of a CD-R/RW drive according to the present invention.

Fig.4 is a perspective view of an optical power calibration performed in a last possible lead-out area.

15 Fig.5 is a flowchart of the optical power calibration according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

20 Please refer to Fig. 3. Fig. 3 is a perspective view of a CD-R/RW drive 30, according to the present invention. The CD-R/RW drive 30 comprises an access device 32 and a control apparatus 36. The access device 32 reads data from and writes data onto the CD 34. The control  
25 apparatus 36 controls the access device 32 to perform optical power calibration and to write data on the CD 34, according to the calibration result.

30 The CD 34 is a thin disk with symmetry about a centerline 31. The related specifications and functionality of the CD 34 can be found in the Orange Book. From the center toward the outer edge, the CD 34 comprises a central portion 38, an inner power calibration area 40, a data storage area 46, and a last  
35 possible lead-out area 48. The central portion 38 comprises a center hole and a clamping area. The inner power calibration area 40 allows for 100 optical power calibrations. The CD 34 further comprises a program

memory area (PMA) and a lead-in area (not shown). Both areas are located between the inner power calibration area 40 and the data storage area 46.

5 According to the standard specification described in the Orange Book, the CD's outer edge should reserve a predetermined length of data track corresponding to at least one and a half minutes (01:30:00) at normal playing speed. This area (the length of data track mentioned above) is the so-called last possible lead-out area 48 of the CD 34. The starting point of the last possible lead-out area 48 is called a last possible start time 50. Typically, right after termination of a data writing action, the CD-R/RW drive 15 34 will immediately write an ending message into the lead-out area 48.

Please refer to Fig. 4. Fig. 4 is a perspective view of the optical power calibration performed in the last possible lead-out area 48. A prior art CD-R/RW drive performs optical power calibration in the inner power calibration area 40. However, according to the present invention, an outer power calibration area 52 is defined in the last possible lead-out area 48, so that an optical power calibration can be performed in the outer power calibration area 52.

As shown in Fig. 4, the outer power calibration area 52 comprises a test area 54 for allowing the test data written thereon during the power calibration and a count area 56 for recording a number count of the power calibrations already performed in the outer power calibration area 52. In an implementation example according to the present invention, the test area 54 and the count area 56 are divided into 100 partitions 54a, 56a, respectively.

Typically, 15 frames are necessary for performing

each optical power calibration. Therefore, 1500 frames are necessary for performing 100 optical power calibrations. The 1500 frames are corresponding to 20-second period (00:20:00) at the normal playing speed of a CD-R/RW drive. According to the CD specification described in the Orange Book, the length of the last possible lead-out area 48 of a CD should be at least corresponding to one and a half minutes (01:30:00) at the normal playing speed. Moreover, some manufacturers supply CDs where the length of the last possible lead-out area 48 is 01:50:00 which is much longer than the 20 seconds which correspond to 100 optical power calibrations. So, if it is possible to reserve enough length of the last possible lead-out area 48 for recording the ending messages of a CD, then the extra length of the last possible lead-out area 48 may be used for optical power calibration.

As shown in Fig.4, according to the present implementation, the predetermined length separation 66 is disposed between the starting point 58 of the outer power calibration area 52 and the last possible start time 50 (the starting point of the last possible lead-out area 48). The predetermined length separation 66 is reserved at least 1 minute (01:00:00), which is long enough for recording the ending message. There is enough length of data track left in the lead-cut area 48 for defining an outer power calibration area of at least 20-second (00:20:00) period, which is long enough for performing 100 optical power calibrations.

Please refer to Fig. 5. Fig. 5 is a flow chart of an optical power calibration according to the present invention. The method of optical power calibration according to the present invention comprises the following steps:

Step 100: provide data to be written;

Step 102: determine the number of optical power calibrations that have been performed on the CD 34;

Step 104: if the number of optical power calibrations is less than 100, control the access device 32 to perform the calibration in the inner power calibration area 40 in Fig 3, else perform the calibration in the outer power calibration area 52.

Step 106: according to the calibration result, determine the optimized optical power, and then control the access device 32 to write further information to the CD 34.

It should be noted that even though the step order of the calibration procedure mentioned above performs calibration in the inner power calibration area 40 first, then performs calibration in the outer power calibration area 52, this order is still arbitrary. The relative position between the outer power calibration area 52 and the last possible lead-out area 48 is for example only. In fact, a requirement according to many embodiments of the present invention is that the setup of the outer power calibration area 52 should not obstruct the function of the last possible lead-out area 48.

In contrast to the prior art, where optical power calibration is only performed in the inner power calibration area 40, the present invention provides a method of optical power calibration with calibration in the outer edge of a CD. Calibration takes place in both the inner power calibration area 40 and in the outer power calibration area 52, so that more calibrations may be performed on a CD.

Those skilled in the art will readily observe that numerous modifications and alterations of the method may be made while retaining the teachings of the

